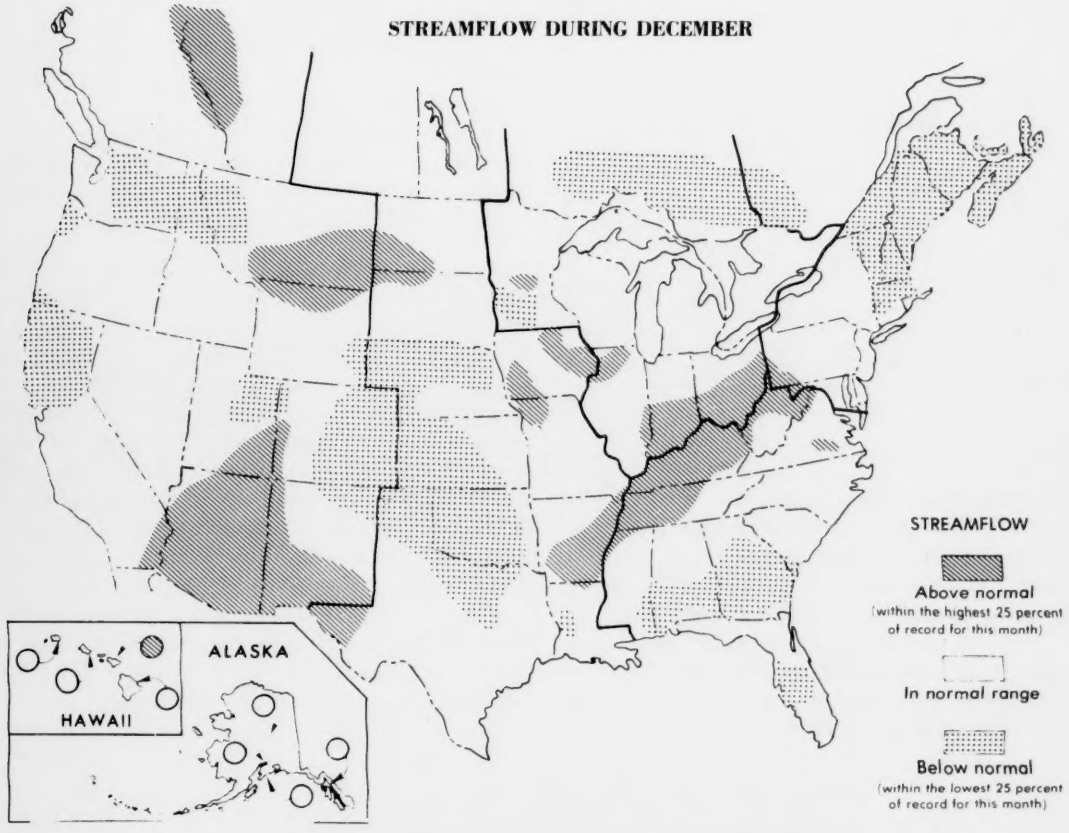
WATER RESOURCES REVIEW for DECEMBER 1978

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CANADA
DEPARTMENT OF THE ENVIRONMENT
WATER RESOURCES BRANCH



STREAMFLOW AND GROUND-WATER CONDITIONS

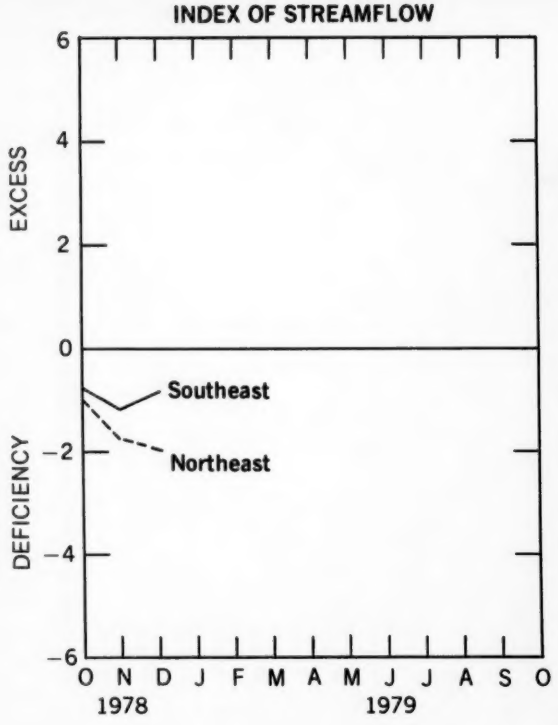
Streamflow generally increased seasonally in Arizona, Oregon, and in most States in the eastern half of the United States, and decreased seasonally in southern Canada, Alaska, Colorado, Oklahoma, and North Central States from Montana to Michigan. Elsewhere, flows were variable.

Below-normal streamflow persisted in large areas in and adjacent to Maine, Alabama, and western Kansas, and also in parts of several States in the Pacific Northwest. Monthly mean flows were lowest of record for December in parts of Maine, Nova Scotia, Colorado, and Kansas.

Flows were in the above-normal range in large areas centered on Arizona, Kentucky, and southeastern Montana, and were highest of record for December in parts of Arizona, Kentucky, New Mexico, and North Dakota. Flooding occurred in Arizona, Kentucky, New Mexico, Ohio, and West Virginia.

Ground-water levels in the Northeast Region generally rose, reversing the declining trends of November, but continued below average in the north. Trends were mixed in parts of the Southeast Region, but generally rose in Kentucky, North Carolina, Alabama, and Georgia; levels were mixed regionally with respect to average. Mixed trends prevailed regionally in the Western Great Lakes and Midcontinent Regions, but there were generally declines in Wisconsin and North Dakota and rises in Ohio and Nebraska. Levels were near or above average in the Western Great Lakes, and mixed above and below average in the Midcontinent. Mixed trends and averages prevailed in the West.

New low levels for December occurred in Arizona, Arkansas, Georgia, Idaho, Kansas, Louisiana, Maine, Nevada, Tennessee, Texas, and Washington; a new December high was reached in West Virginia. A new alltime low occurred in Arizona and a new alltime high was reached in Kentucky.



The index of streamflow is computed by multiplying the percent of a region that is deficient or excessive by the average duration of deficiency or excess. Thus, the index of streamflow deficiency for the Northeast during December worsened to a value of -2.0 when 50 percent (i.e., 0.50) of the area in the Northeast Region was deficient for an average duration of 4 months. The index of streamflow deficiency in the Southeast Region improved to a value of -0.9 during December.

NORTHEAST

[Atlantic Provinces and Quebec; Delaware, Maryland, New York, New Jersey, Pennsylvania, and the New England States]

Streamflow generally decreased seasonally in New Brunswick and Quebec, was variable in Nova Scotia and Maine, and increased seasonally elsewhere in the region. Monthly mean flows remained in the below-normal range in parts of the Atlantic Provinces, Quebec, Maine, and most of central New England, and were lowest of record for December in parts of Nova Scotia and Maine. Mean flows increased into the above-normal range in southwestern Pennsylvania.

Ground-water levels rose in most of the region, reversing the falling or static trends of November. However, levels remained below average in northern parts of the region, especially in Maine.

In New Hampshire, where mean flow in Pemigewasset River at Plymouth was in the below-normal range and lowest of record during November, flow increased seasonally but remained in the below-normal range for the 2d consecutive month and was only 35 percent of median. (See graph on page 3.) Monthly mean flows at index stations in Massachusetts and Vermont also increased seasonally, were about one-half their respective median flows, and remained in the below-normal range. At the index station, Passumpsic River at Passumpsic, Vt., runoff was the third lowest for December since record began in October 1928.

In Maine, monthly mean discharge remained in the below-normal range at all index stations. In the central part of the State, the monthly mean flow of 46.9 cfs in Piscataquis River near Dover-Foxcroft (drainage area, 297 square miles), was lowest for December in 76 years

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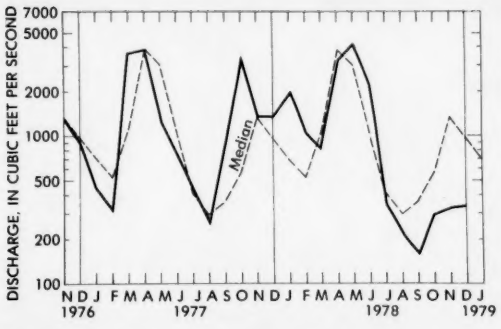


Monthly mean discharge of Pemigewasset River at Plymouth, New Hampshire (Drainage area, 622 sq mi; 1,611 sq km)

of record. Mean flows in the below-normal range have persisted for 6 consecutive months at that site and also at the index station, Little Androscoggin River near South Paris, in the southern part of the State.

North of the St. Lawrence River in southwestern Quebec, monthly mean discharge of Harricana River at Amos decreased seasonally, was only 71 percent of median, and remained in the below-normal range for the 5th consecutive month. Monthly mean flow of Coulonge River near Fort-Coulonge decreased seasonally to less than one-half the median flow and was below the normal range. Also in Quebec, but south of the St. Lawrence River, mean flow of St. Francois River at Hemmings Falls decreased seasonally and remained below the normal range for the 2d consecutive month, as a result of low carryover flow from November. Monthly mean flows at index stations in central and eastern Quebec generally decreased seasonally, were less than median, but were within the normal range.

Runoff in the Atlantic Provinces was unseasonably low for the second consecutive month, the direct result of continued light precipitation. Monthly mean flows remained in the below-normal range at all five index stations and ranged from 16 to 53 percent of median. In southern Nova Scotia, the monthly mean flow of 589 cfs in LaHave River at West Northfield (drainage area, 484 square miles) was lowest for December in 63 years of continuous record, and considerably lower than the previous low of 727 cfs that occurred in December 1947. Mean flow has remained in the below-normal range for 7 consecutive months at LaHave. In northern New Brunswick, monthly mean discharge of Upsalquitch River at Upsalquitch (drainage area, 877 square miles) decreased seasonally, remained in the below-normal range for the 6th consecutive month, and at 733 cfs, was only 1 cfs greater than the record low for December that occurred in 1947.

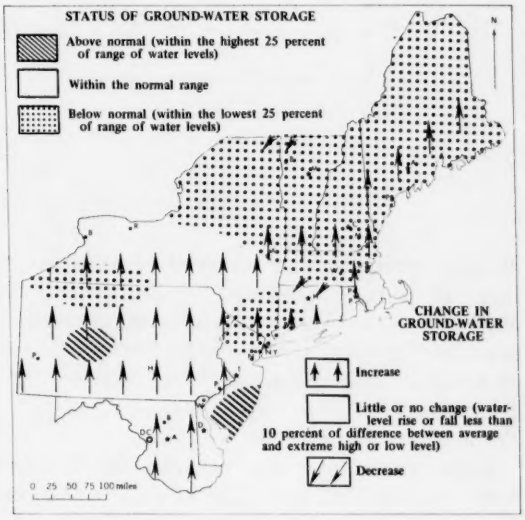
In Connecticut, streamflow increased seasonally at all index stations and was in the normal range throughout most of the State. However, monthly mean flow of Burlington Brook near Burlington, in the northwestern part of the State, was only 52 percent of median and remained in the below-normal range.

In Maryland, New Jersey, and New York, monthly mean flow increased seasonally at all index stations and was in the normal range throughout the tristate area.

In southwestern Pennsylvania, monthly mean discharge of Monongahela River at Braddock increased sharply as a result of runoff from rains early in the month and was above the normal range at 265 percent of median. Elsewhere in the State, monthly mean flows at all index streams were above median but within the normal range.

Monthly mean flow of Potomac River near Washington, D.C. increased sharply, as a result of runoff from rains near monthend, but was within the normal range at 141 percent of median.

Ground-water levels rose in most of the region. (See map.) However, levels remained below average in northern and central New England, and parts of northeastern and southeastern New York and adjacent northern New Jersey. Levels continued especially low in parts of Maine.

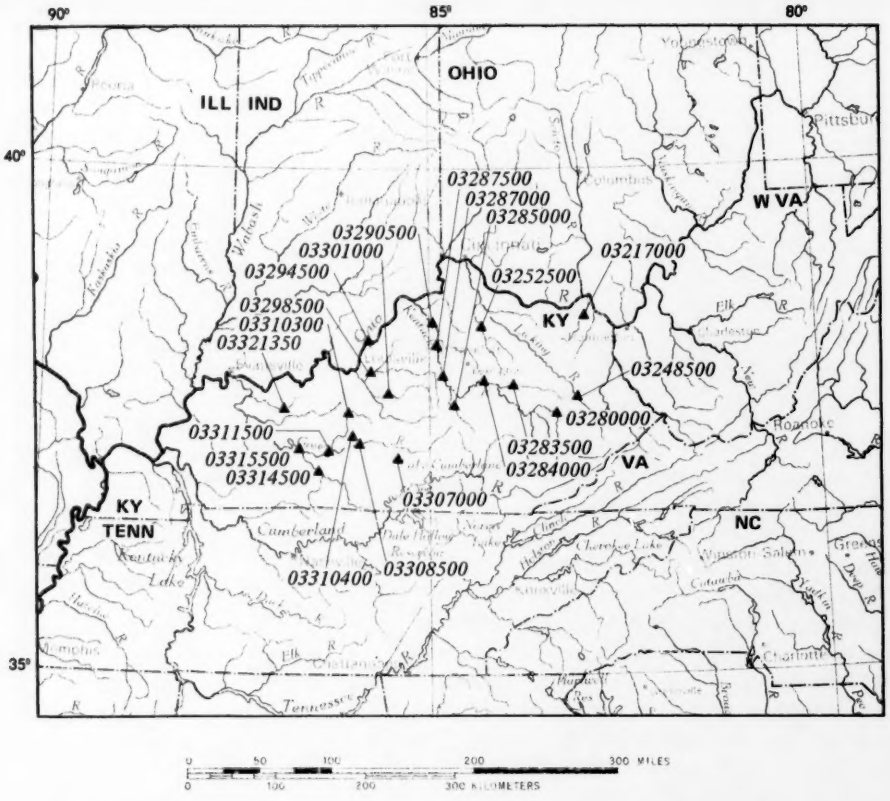


Map shows ground-water storage near end of December and change in ground-water storage from end of November to end of December.

SOUTHEAST

[Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia]

Streamflow increased seasonally in all States of the region except Florida, where flows generally decreased.



Location of stream-gaging stations in Kentucky, described in table of peak stages and discharges.

Monthly mean discharges remained below the normal range in parts of Alabama, Florida, Georgia, and Mississippi. Mean flows remained in the above-normal range, and were highest of record for December, in parts of Kentucky, and increased into that range in parts of Tennessee and West Virginia. Flooding occurred in Kentucky and West Virginia.

Ground-water levels rose in Kentucky, Tennessee, North Carolina, Alabama, and Georgia; trends were mixed elsewhere. Levels were above average in Kentucky, below average in most of Florida, slightly below average in Alabama, and mixed elsewhere. A new alltime high occurred in Kentucky in response to very heavy rains; new lows for December were recorded in Tennessee and Georgia.

Flooding occurred early in the month in many parts of Kentucky as a result of rapid runoff from rainfall of 3 to 8 inches, December 8–10, as reported by the National Weather Service. Some of the most notable flooding was in the Kentucky River basin in the north-central part of the State and damage was reported to have been severe in Frankfort and other cities situated on flood plains. Peak discharges at several stream-gaging stations in the State were greater than those of a 100-year flood at the respective sites. Selected data on stages, discharges, recurrence-intervals, and gaging station locations, are given in the accompanying map and table (on page 5). In Licking River basin, adjacent to Kentucky River basin in northern Kentucky, the monthly mean discharge of 21,790 cfs, and the daily mean of 60,200 cfs on the 10th, were greatest for December in 53 years of record at the index station, Licking River at Catawba (drainage area, 3,300 square miles). Similarly, in south-central Kentucky, the monthly mean flow of 17,620 cfs, and the daily mean of 57,200 cfs on the 10th, were greatest for the month in 53 years of record at the index station, Green River at Munfordville (drainage area, 1,673 square miles).

Flooding occurred also in adjacent parts of western West Virginia, as a result of runoff from the rainfall of December 8–10, and was especially notable in Twelvepole Creek basin. The peak discharge of 4,300 cfs on the 9th at the gaging station, East Fork Twelvepole Creek

Provisional data; subject to revision

FLOOD DATA FOR SELECTED SITES IN KENTUCKY, DECEMBER 1978

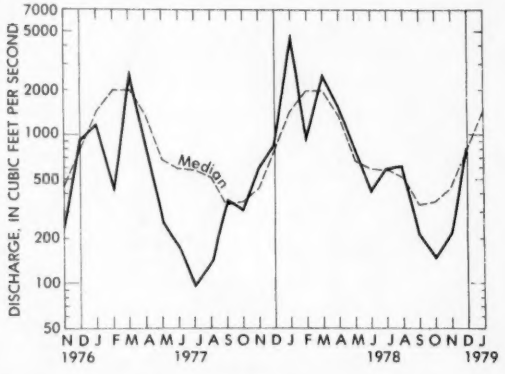
WRD station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known			Maximum during present flood				
				Date	Stage (feet)	Discharge (cfs)	Date	Stage (feet)	Discharge		Recurrence interval (years)
									Cfs	Cfs per square mile	
	KENTUCKY										
	TYGARTS CREEK BASIN										
03217000	Tygarts Creek near Greenup.	242	1940–	Feb. 28, 1962	21.38	14,800	Dec. 9	22.75	18,500	76	50
	LICKING RIVER BASIN										
03248500	Licking River near Salyersville.	140	1938–	Feb. 3, 1939	25.4	14,300	9	24.9	13,200	94	20
03252500	South Fork Licking River at Cynthiana.	621	1938–	Apr. 13, 1948	23.32	35,300	9	22.4	26,900	43	10
	KENTUCKY RIVER BASIN										
03280000	North Fork Kentucky River at Jackson.	1,101	1928–31, 1937–	Jan. 30, 1957	[1] 40.41	53,500	9	35.03	38,000	35	5
03283500	Red River at Clay City ...	362	1930–32, 1938–	Feb. 28, 1962	23.90	22,600	9	26.9	27,500	76	50
03284000	Kentucky River at lock 10, near Winchester.	3,955	1907–	Feb. 5, 1939	34.8	92,400	9	40.2	100,000	25	>100
03285000	Dix River near Danville ..	318	1942–	Apr. 28, 1970	12.16	33,400	9	21.85	55,500	175	>100
03287000	Kentucky River at lock 6, near Salvisa.	5,102	1925–	Jan. 23, 1937	43.35	112,000	9	49.1	120,000	24	>100
03287500	Kentucky River at lock 4, at Frankfort.	5,412	1905–6, 1925–	Jan. 25, 1937	47.46	115,000	10	48.4	112,000	21	>100
03290500	Kentucky River at lock 2, at Lockport.	6,180	1925–	Jan. 26, 1937	[2] 56.85	123,000	11	51.7	116,000	19	100
	OHIO RIVER MAIN STEM										
03294500	Ohio River at Louisville ..	91,170	1928–	Jan. 26, 27, 1937	85.44	1,110,000	14	63.5	643,000	7.1	8
	SALT RIVER BASIN										
03298500	Salt River at Shepherdsville.	1,197	1937–	Mar. 10, 1964	[3] 41.50	78,200	10	32.2	55,300	46	33
03301000	Beech Fork at Bardstown.	669	1939–	Mar. 5, 1964	43.5	33,900	9	46.0	39,000	58	30
	GREEN RIVER BASIN										
03307000	Russell Creek near Columbia.	188	1939–	Feb. 27, 1962	24.34	29,700	9	24+	20,400	109	67
03308500	Green River at Munfordville.	1,673	1913, 1916–22, 1925–	Mar. 1, 1962	57.72	76,800	10	51.9	61,800	37	33
03310300	Nolin River at White Mills.	357	1959–	Apr. 29, 1970	34.86	19,400	9	34+	18,500	52	25
03310400	Bacon Creek near Priceville.	85.4	1957, 1959–	Feb. 24, 1975	[4] 15.2	3,350	9	19.8	6,100	71	>100
03311500	Green River at lock 6, at Brownsville.	2,762	1924–31, 1936–37, 1938–	Jan. 24, 1937	44.94	120,000	11	37.3	70,000	25	15
03314500	Barren River at Bowling Green.	1,848	1913, 1938–	Feb. 28, 1962	[5] 49.55	85,000	10	48+	54,000	29	10
03315500	Green River at lock 4, at Woodbury.	5,403	1936–	Jan. 25, 1937	43.1	205,000	11	[6] 49.06	102,000	19	100
03321350	South Fork Panther Creek near Whitesville.	58.2	1968–	Feb. 18, 1976	[7] 17.36	3,300	8	17.32	3,200	55	>100

[1] Occurred at different time than peak discharge; maximum gage height, 43.10 ft. on Feb. 4, 1939.
[2] Backwater from Ohio River; occurred Jan. 24, 1937.
[3] Maximum gage height of 47.3 ft. occurred Jan. 26, 1937 (backwater from Ohio River).
[4] Flood in November 1957 reached a stage of 21.8 feet.
[5] Flood of Jan. 8, 1913 reached a stage of 52.2 feet.
[6] Tailwater gage.
[7] Maximum gage height, 18.18 feet Apr. 2, 1970.

near Dunlow (drainage area, 38.2 square miles) was the greatest since records began in October 1964 and was greater than that of a 100-year flood at that site. In the extreme northern part of the State, mean flow of Potomac River at Paw Paw increased sharply, was 175 percent of the December median, and was above the normal range. In eastern and southern parts of the State, flows generally increased seasonally and were within the normal range.

In north-central Virginia, where monthly mean discharge of Rapidan River near Culpeper was below the normal range and only one-half the median flow in October and November, mean discharge increased sharply to about 1½ times median and was within the normal range. In the southeastern part of the State, mean flow of Nottaway River near Stony Creek also increased sharply, was almost 2 times the December median discharge, and was in the above-normal range. Elsewhere in Virginia, monthly mean flows increased seasonally, were equal to or greater than median, and remained in the normal range.

In the eastern Piedmont and Coastal Plain of North Carolina, where monthly mean flow of Neuse River near Clayton was below the normal range and less than one-half median in October and November, mean flow increased sharply in December, was near median and was within the normal range. (See graph.) Similarly, in the Tennessee River basin in the extreme western part of the State, monthly mean flow of French Broad River at Asheville increased sharply and was in the normal range after two consecutive months of flow in the below-normal range.



Monthly mean discharge of Neuse River near Clayton, N.C. (Drainage area, 1,140 sq mi; 2,953 sq km)

In eastern South Carolina, where mean flows of Lynches River at Effingham and Pee Dee River at Peedee were below the normal range in October and November, monthly mean discharges increased sharply and were within the normal range for the 5th time in the past 7 months.

In extreme northern Georgia, where mean flow of Etowah River at Canton was in the below-normal range in October and November, monthly mean discharge increased sharply and was in the normal range. In eastern and southern parts of the State, mean flows of Altamaha River at Doctortown and Alapaha River at Statenville increased seasonally but remained below the normal range for the 4th and 5th consecutive months, respectively. In extreme western Georgia and the adjacent areas of eastern Alabama and northern Florida, mean flow of Apalachicola River, as measured at Chattahoochee, Fla., also increased seasonally and was in the below-normal range for the 2d consecutive month.

In west-central Florida, mean flow of Peace River at Arcadia continued to decrease seasonally and remained below the normal range for the 4th consecutive month. In the east-central part of the State, mean flow of St. Johns River near Christmas was only 24 percent of the median discharge for December. Elsewhere in the State, mean flows were in the normal range and less than median.

In southeastern Alabama, monthly mean discharge of Conecuh River at Brantley increased seasonally but remained in the below-normal range for the 4th consecutive month. In other parts of the State, mean flows also increased seasonally and were less than median but were within the normal range.

In southeastern Mississippi, mean flow of Pascagoula River at Merrill increased seasonally but was in the below-normal range for the 4th consecutive month. Cumulative runoff at this site for the first quarter of the 1979 water year was only 48 percent of median. In other parts of the State, mean flows increased from the below-normal range in November into the normal range in December but were less than the median flows for the month.

In western Tennessee, monthly mean flow of Buffalo River near Lobelville increased sharply as a result of runoff from rains early in the month, and was in the above-normal range for the 5th time in the past 8 months. Cumulative runoff at this station for the first quarter of the 1979 water year was 189 percent of median. In the extreme eastern part of the State, where monthly mean flows of French Broad River below Douglas Dam were below the normal range and only one-third and one-half the respective median flows in October and November, mean discharge increased sharply in December into the normal range and was 99 percent of median. In central Tennessee, monthly mean flow of Harpeth River near Kingston Springs increased sharply as a result of runoff from the rains of December

8, 9, was above the normal range, and was 4 times the December median discharge.

Ground-water levels in West Virginia declined in the northern fourth of the State and rose elsewhere; levels were above average in the southwestern half of the State and were generally below average elsewhere. In Kentucky, levels rose sharply in response to extremely heavy rains and high stream stages. Levels were above average and at or near alltime record highs in most of the Commonwealth. A new high level was reached in the observation well in Louisville in 33 years of record. Levels in Virginia showed mixed trends and were above and below average. In western Tennessee, the artesian level in the key well in the "500-foot sand" near Memphis rose slightly but was at a new low level for December in 38 years of record, and continued nearly 16 feet below average. In North Carolina, levels rose statewide, and were below average in the Coastal Plain, and above average in the mountains and in the Piedmont. Levels continued moderate declines in northeastern Mississippi and along the Gulf Coast. However, in the Jackson area, wells in the Sparta Sand showed slight rises. Levels in Alabama generally rose but were slightly below average. In Georgia, levels rose in the Piedmont and in the principal aquifer in the coastal counties. The level in the Cockspur Island well in the Savannah area rose slightly but nevertheless continued more than 7 feet below average and was at a new low for December in 23 years of record. In southwestern Georgia, levels rose as much as 4 feet. In Florida, levels rose in most areas in the north but generally declined in the central peninsula and in the southeast. Levels were mostly below average in the State except near Pensacola, where they were about 3.5 feet above average.

WESTERN GREAT LAKES REGION

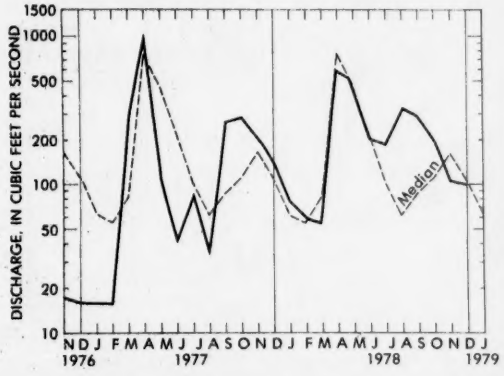
[Ontario; Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin]

Streamflow increased seasonally in Illinois, Indiana, and Ohio, but generally decreased in the northern States of the region and in Ontario. Monthly mean flows remained in the below-normal range in parts of Minnesota and decreased into that range in parts of Ontario. Mean flows remained in the above-normal range in parts of Indiana, Minnesota, and Ohio, and increased into that range in parts of Illinois. Flooding occurred in southern Ohio.

Ground-water levels held steady in Indiana, rose slightly in Ohio and Illinois, declined in Wisconsin and in most of Michigan, and showed mixed trends in Minnesota. Levels were near normal in Wisconsin, Indiana, and Ohio, mixed with respect to average in Minnesota, and were mostly above normal in Michigan and Illinois.

In southern Ohio, rapid runoff from intense rains December 6, 7, resulted in minor flooding along some of the smaller streams. In the central part of the State, monthly mean flow of Scioto River at Higby increased sharply, was nearly 5 times median, and remained above the normal range for the 4th consecutive month. Cumulative runoff at that station for the first quarter of the 1979 water year was about 3 times median. In northeastern Ohio, mean flow of Little Beaver Creek near East Liverpool also increased sharply, was 411 percent of the December median, and was in the above-normal range for the 15th time in the past 18 months. Cumulative runoff for the first quarter of the 1979 water year was 314 percent of median at this index station. Monthly mean flows in the northwestern part of the State were in the normal range.

In the western part of Michigan's Upper Peninsula, monthly mean discharge of Sturgeon River near Sidnaw decreased seasonally and was slightly less than median but was within the normal range. (See graph). In the northern part of the Lower Peninsula, mean flow of Muskegon River at Evart also decreased seasonally, was slightly less than median, and remained in the normal range. In the southern part of the Lower Peninsula, mean flow of Red Cedar River at East Lansing continued to increase seasonally but remained in the normal range for the 4th consecutive month.



Monthly mean discharge of Sturgeon River near Sidnaw, Mich. (Drainage area, 171 sq mi; 443 sq km)

In southeastern Ontario, mean flow of Saugeen River near Port Elgin also increased seasonally and remained in the normal range. In the eastern part of the Province, monthly mean discharge of Missinaibi River at Mattice decreased seasonally, was in the below-normal range for

(Continued on page 9.)

SELECTED DATA FOR THE GREAT LAKES, GREAT SALT LAKE, AND OTHER HYDROLOGIC SITES

GREAT LAKES LEVELS

Water levels are expressed as elevations in feet above International Great Lakes Datum 1955

(Data furnished by National Ocean Survey, NOAA, via U.S. Army Corps of Engineers office in Detroit. To convert data to elevations above mean sea level datum of 1929, add the following values: Superior, 0.96; Michigan-Huron, 1.20; St. Clair, 1.24; Erie, 1.57; Ontario, 1.22.)

Lake	December 31, 1978	Monthly mean, December		December		
		1978	1977	Average 1900–75	Maximum (year)	Minimum (year)
Superior (Marquette, Mich.)	600.34	600.30	601.05	600.60	601.53 (1974)	598.94 (1925)
Michigan and Huron (Harbor Beach, Mich.)	578.49	578.54	578.30	577.88	579.97 (1973)	575.40 (1964)
St. Clair (St. Clair Shores, Mich.)	573.81	573.56	574.24	572.93	575.21 (1972)	571.05 (1925)
Erie (Cleveland, Ohio)	570.52	570.52	571.11	569.78	572.35 (1972)	567.53 (1934)
Ontario (Oswego, N.Y.)	243.70	243.66	245.08	243.98	246.19 (1945)	241.48 (1934)

GREAT SALT LAKE

Alltime high: 4,211.6 (1873). Alltime low: 4,191.35 (October 1963).	December 31, 1978	December 31, 1977	Reference period 1904–77		
			December average, 1904–77	December maximum (year)	December minimum (year)
Elevation in feet above mean sea level:	4,198.65	4,198.80	4,197.9	4,204.2 (1923)	4,191.85 (1963)

LAKE CHAMPLAIN, AT ROUSES POINT, N.Y.

Alltime high (1827–1977): 102.1 (1869). Alltime low (1939–1977): 92.17 (1941).	December 29, 1978	December 31, 1977	Reference period 1939–75		
			December average, 1939–75	December max. daily (year)	December min. daily (year)
Elevation in feet above mean sea level:	94.04	97.44	95.11	98.30 (1974)	93.25 (1954)

FLORIDA

Site	December 1978		November 1978	December 1977
	Discharge in cfs	Percent of normal	Discharge in cfs	Discharge in cfs
Silver Springs near Ocala (northern Florida)	780	96	770	590
Miami Canal at Miami (southeastern Florida)	312	144	367	200
Tamiami Canal outlets, 40-mile bend to Monroe	58	107	117	80

(Continued from page 7.)
the first time since April 1978, and was only one-half the December median discharge.

In northwestern Wisconsin, monthly mean flow of Chippewa River at Chippewa Falls increased, contrary to the normal pattern of decreasing flow in December, but remained within the normal range. Also in the northwest, mean flow of Jump River at Sheldon decreased seasonally, was less than median, but was in the normal range for the 4th consecutive month. In the west-central part of the State, mean flow of Wisconsin River at Muscoda also decreased seasonally but remained above median and within the normal range. In eastern Wisconsin, mean discharge of Oconto River near Gillett decreased seasonally and remained above median and within the normal range. Also in eastern Wisconsin, where mean flow of Fox River at Rapide Croche Dam, near Wrightstown was above the normal range for 3 consecutive months, September through November, mean flow decreased, contrary to the normal seasonal pattern of increasing flow in December, and was in the normal range.

In northern Illinois, monthly mean discharge of Rock River near Joslin increased seasonally and was in the above-normal range again for the 7th time in the past 8 months. Mean flow of Pecatonica River at Freeport (Pecatonica River is tributary to Rock River) decreased seasonally but remained in the normal range and was greater than median for the 9th consecutive month. In the east-central part of the State, mean discharge of Sangamon River at Monticello increased seasonally and was in the normal range but was only 23 percent of median. In southern Illinois, mean flow of Skillet Fork at Wayne City continued to increase seasonally and was 168 percent of median, but remained within the normal range.

In central Minnesota, mean flow of Mississippi River near Anoka continued to decrease seasonally but was greater than the December median discharge and was in the normal range. Also in the central part of the State, mean discharge of Crow River at Rockford also continued to decrease seasonally but remained in the above-normal range for the 6th consecutive month and was 204 percent of median. Cumulative runoff at this station during the first quarter of the 1979 water year was 273 percent of median. In western Minnesota, where monthly mean flow of Buffalo River near Dilworth was in the below-normal range for 6 consecutive months, June through November, mean flow decreased slightly but was in the normal range. Cumulative runoff at this station was only 53 percent of median for the first quarter of the 1979 water year. In extreme northern Minnesota, monthly mean flow at the international gaging station, Rainy River at Manitou Rapids, on the Minnesota-Ontario boundary, increased, contrary to the normal seasonal pattern of decreasing flow and was 113 percent of median but remained in the normal range.

In southeastern Indiana, monthly mean flow of East Fork White River at Shoals continued to increase seasonally, was 3½ times the December median flow, and remained in the above-normal range for the 8th time in the past 10 months and for the 6th consecutive month. In the extreme southwestern part of the State, mean flow of Wabash River, as measured at the Indiana-Illinois border at Mt. Carmel, Ill., increased seasonally and was above the normal range for the 8th time in the past 10 months. In northern Indiana, monthly mean discharge of Mississinewa River at Marion also continued to increase seasonally but remained within the normal range for the 4th consecutive month.

Ground-water levels in shallow observation wells in Minnesota declined and continued below average. Artesian levels in the Minneapolis-St. Paul area continued to rise slightly and were above average in the two principal aquifers. Levels in shallow aquifers in Wisconsin declined seasonally and were generally near average. In Michigan, levels rose in the central part of the Lower Peninsula, but generally declined elsewhere; they were above average in most parts of the State. In Illinois, the level in the shallow index well in glacial drift at Princeton, in Bureau County, continued to rise and continued more than 4 feet above average. Levels in Indiana held steady and were near average. In Ohio, levels rose slightly and were about average.

MIDCONTINENT

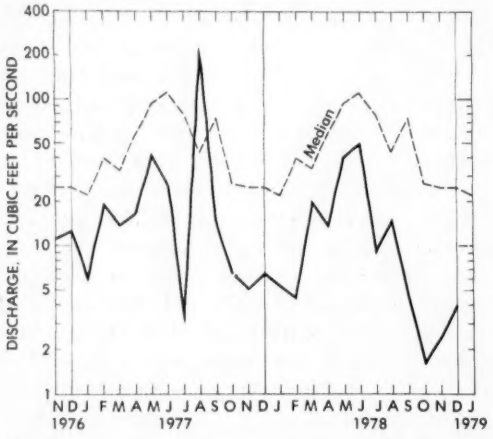
[Manitoba and Saskatchewan; Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas]

Streamflow increased seasonally in Arkansas, Louisiana, and Nebraska, decreased in Iowa, Manitoba, North Dakota, Oklahoma, Saskatchewan, and South Dakota, and was variable in Missouri, Nebraska, and Texas. Monthly mean flows remained in the above-normal range in parts of Arkansas, Iowa, Missouri, and North Dakota, and remained below the normal range in parts of Kansas, Louisiana, Nebraska, Oklahoma, and Texas. Monthly mean discharge was lowest of record for December in parts of Kansas, and highest for December in parts of North Dakota.

Ground-water levels declined in North Dakota, rose statewide in Nebraska, and showed mixed trends in other States in the region. Levels were below average in Kansas and Louisiana, generally above average in Iowa,

and mixed with respect to average elsewhere. New low levels for December occurred in Kansas, Arkansas, Louisiana, and Texas.

In northwestern Kansas, where record-low discharges occurred at the index station, Saline River near Russell (drainage area, 1,502 square miles) in September, October, and November, the monthly mean discharge of 4.0 cfs was lowest for December in 28 years of record. (See graph.) In the southern part of the State, monthly mean flow of Arkansas River at Arkansas City decreased seasonally, was below the normal range, and continued at 45 percent of median.

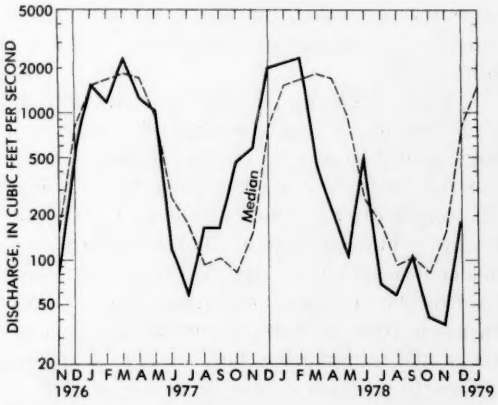


Monthly mean discharge of Saline River near Russell, Kans. (Drainage area, 1,502 sq mi; 3,890 sq km)

In south-central Oklahoma, monthly mean flow of Washita River near Durwood also decreased seasonally, was only 38 percent of median, and was in the below-normal range for the 5th consecutive month. Cumulative runoff at this station for the first quarter of the 1979 water year was 21 percent of median.

In eastern Texas, mean flow of Neches River near Rockland continued to increase seasonally but remained in the normal range and was only one-half the December median discharge. Cumulative runoff at this station for the first quarter of the 1979 water year was one-half the median. Also in eastern Texas, mean flow of North Bosque River near Clifton decreased, remained below the normal range for the 7th consecutive month, and was only 10 percent of the median discharge for December. Cumulative runoff at this station, October through November, was 6 percent of median for that period. Mean flows in parts of the Colorado, Brazos, Trinity, Sabine, and Sulphur River basins, in the central and northern parts of the State, were reported to be in the below-normal range. In central Texas, monthly mean flow of Guadalupe River near Spring Branch decreased, contrary to the normal seasonal pattern of increasing flow, and was in the normal range, following a period of 4 consecutive months of above-normal flow at this station. Cumulative runoff there was 278 percent of median for the first quarter of the 1979 water year.

In west-central Louisiana, where monthly and daily mean discharges of Calcasieu River near Oberlin were lowest of record for November, mean flow increased sharply, as a result of runoff from rains near midmonth, but remained below the normal range for the 5th consecutive month and was only 23 percent of median. (See graph.) Mean flow of Red River at Alexandria was 79 percent of median and mean flow of Mississippi River at Baton Rouge was 2 times the December median discharge and was the 5th highest for the month since records began in 1928.



Monthly mean discharge of Calcasieu River near Oberlin, La. (Drainage area, 753 sq mi; 1,950 sq km)

In north-central Arkansas, monthly mean discharge of Buffalo River near St. Joe continued to increase seasonally and remained within the normal range. In the south-central part of the State, mean flow of Saline River near Rye also continued to increase seasonally, remained in the above-normal range, and was 5½ times the December median discharge.

In northwestern Missouri, mean discharge of Grand River near Gallatin decreased, but remained above the normal range as a result of high carryover flow from November, and was about 4 times the December median discharge. In the south-central part of the State, mean discharge of Gasconade River at Jerome increased seasonally and was greater than median, but remained within the normal range for the 9th consecutive month.

In southwestern Iowa, mean flow of Nishnabotna River above Hamburg decreased seasonally, was 2½ times median, and remained in the above-normal range

for the 4th consecutive month. In the eastern part of the State, mean discharge of Cedar River at Cedar Rapids decreased seasonally but was in the above-normal range and about 2 times the December median flow. Elsewhere in the State, mean flows remained in the normal range.

In central South Dakota, no flow occurred during December in Bad River near Fort Pierre. In the eastern part of the State, mean flow of Big Sioux River, as measured at Akron, Iowa, continued to decrease seasonally, was less than median for the 3d consecutive month, and was in the normal range for the 8th consecutive month.

In southwestern Nebraska, monthly mean flows of unregulated streams in the Republican River basin were reported to be between about 40 percent and 80 percent of normal. Reservoirs on the regulated streams were reported to be filling slowly. In the panhandle area of northwestern Nebraska, mean flow of Niobrara River above Box Butte Reservoir increased slightly but remained below the normal range and was only 63 percent of median. In the eastern part of the State, monthly mean discharge of Elkhorn River at Waterloo increased, contrary to the normal seasonal pattern of decreasing flow in December, but remained below the normal range for the 4th consecutive month. Elsewhere in the State, mean flows were reported to be within the normal range.

In southwestern North Dakota, the monthly mean discharge of 39 cfs at the index station, Cannonball River at Breien (drainage area, 4,100 square miles) was highest for December since records began in August 1934. Mean discharge has been above the normal range at that station in 12 of the last 15 months and cumulative runoff during the first quarter of the 1979 water year was 281 percent of median. In the eastern part of the State, mean flow of Red River of the North at Grand Forks continued to decrease seasonally and remained below median and in the normal range.

In southeastern Saskatchewan, monthly mean flow of Qu'Appelle River near Lumsden decreased, was slightly less than median, and remained within the normal range for the 5th consecutive month.

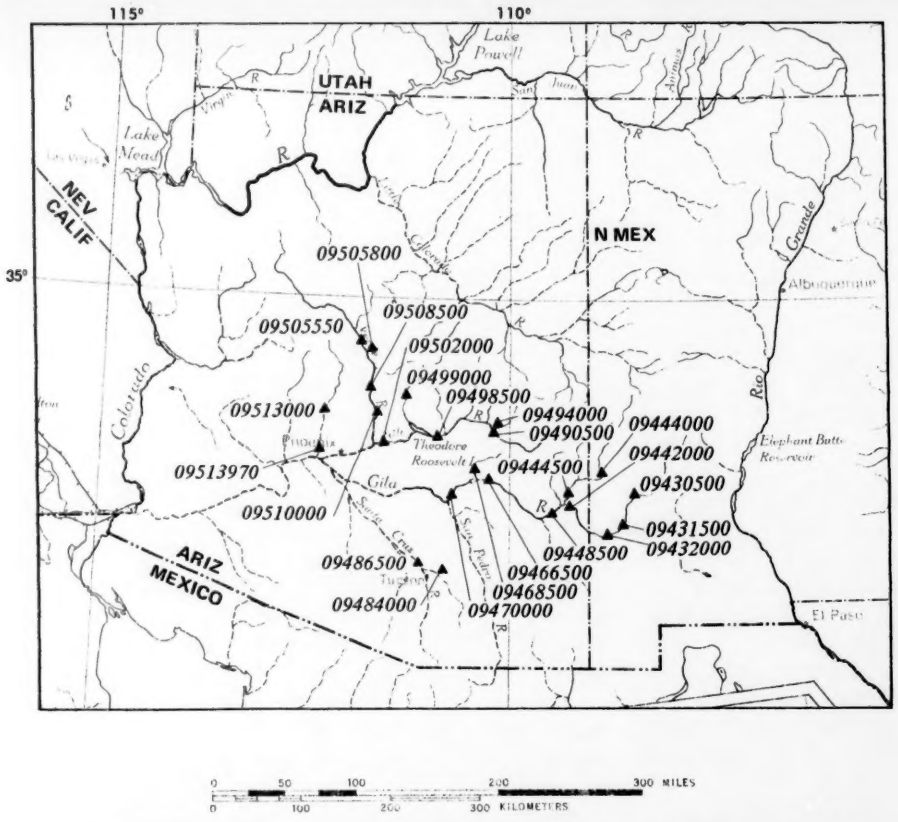
In southern Manitoba, monthly mean discharge of Waterhen River below Waterhen Lake decreased seasonally, was about two-thirds the December median flow, and was in the normal range for the 27th consecutive month. The level of Lake Winnipeg at Gimli averaged 714.09 feet above mean sea level for the month, 0.10 foot lower than last month, 1.87 feet higher than last December, 0.99 foot higher than the long-term average for December, and 1.92 feet lower than the maximum December mean for the period of record, that began in 1913 at Winnipeg Beach.

Ground-water levels in North Dakota declined slightly and were below average in the east but slightly above average in the west. Levels in Nebraska rose statewide and were near average except where there had been intensive pumping of ground water for irrigation. In Iowa, levels in shallow wells declined in some areas, and rose in others in response to thawing of snow cover; levels were generally above average. In Kansas, levels continued near record lows; a new low for December was recorded in the key well at Colby, in Thomas County, despite a rise of more than a foot; this well taps the Ogallala Formation, and has 31 years of record. Levels in eastern Kansas held steady. In the rice-growing area of east-central Arkansas, levels rose slightly in the shallow aquifer, and the level rose considerably——more than 78 feet——in the key well in the deep Sparta Sand aquifer, as a result of post-irrigation recovery, and was nearly 5 feet above average. The level in the key well in the industrial area at Pine Bluff, also in the Sparta Sand, declined slightly and was 22 feet below average, at a new low for December in 12 years of record. The level at El Dorado rose very slightly but was more than 19 feet below average. In Louisiana, levels in key wells screened in the Sparta and Miocene aquifers of the northern and central sections were near record lows but fluctuations in the Wilcox and Cockfield were seasonal. Levels in the terrace aquifers began their seasonal rise. Levels in the sands of the many southeastern aquifers mostly declined although those in the sands in the Baton Rouge and New Orleans areas showed mixed trends. Levels in wells in the rice-growing area of the southwest showed some recovery from seasonal lows of midsummer; even so, the level in the key well near Iowa, La., was at a new low for December in 38 years of record. In Texas, levels in key wells in the Edwards Limestone rose at Austin and declined at San Antonio; levels were above average. In the Evangeline aquifer at Houston, levels rose; nevertheless, the level was at a new December low in 14 years of record in the key well, and was nearly 28 feet below average. The level in the key well in the bolson deposits at El Paso declined and reached a new December low in 21 years of record.

WEST

[Alberta and British Columbia; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming]

Streamflow decreased seasonally in Alberta, British Columbia, Colorado, and Montana, increased seasonally in Arizona and Oregon, and was variable elsewhere in the region. Monthly mean discharges remained below the



Location of stream gaging stations in New Mexico and Arizona, described in table of peak stages and discharges.

normal range in parts of California, Colorado, Idaho, Montana, Oregon, Utah, and Washington, and decreased into that range in parts of New Mexico. Above-normal streamflow persisted in parts of Alberta, Arizona, Montana, and New Mexico. Mean flows were highest of record for December in parts of Arizona and New Mexico and lowest of record for the month in parts of Colorado. Flooding occurred in Arizona and New Mexico.

Ground-water levels declined in Washington, and declined or held steady in Idaho; trends were mixed elsewhere in the region. Levels were below average in Washington and Idaho, but were mixed with respect to average elsewhere. New lows for December occurred in Washington, Idaho, Nevada, and Arizona; a new alltime low was reached in Arizona.

Severe flooding occurred December 18–20 in western New Mexico and southeastern and central Arizona as a result of high elevation rainfall of up to 8 inches in two days on a wet snowpack of 1 to 2 feet that caused extremely high runoff. Flooding extended from New Mexico to northwestern Arizona. Damage was severe in the towns of Clifton, Duncan, and Little Hollywood, a suburb of Safford, and to farmland and crops in the Duncan, York, and Safford Valleys. Reservoirs on the Salt and Verde Rivers were nearly full prior to the flood and the excess runoff necessitated the release of large amounts of water into the Salt River. The resultant peak discharge of 133,000 cfs in Salt River at Phoenix (drainage area, 13,500 square miles) was highest of record since Theodore Roosevelt Dam was constructed in 1910 and exceeded the March 1978 flood by 2,000 cfs. Selected data on stages, discharges, recurrence intervals, and gaging station locations, are given in the accompanying map and table (on page 13). A bridge on Interstate Highway 17 between Phoenix and Flagstaff was destroyed by the flood in Agua Fria River. At least six lives were lost during the flood.

In central Arizona, the daily mean discharge of 91,000 cfs on the 19th of Verde River below Tangle Creek, above Horseshoe Dam (drainage area, 5,872

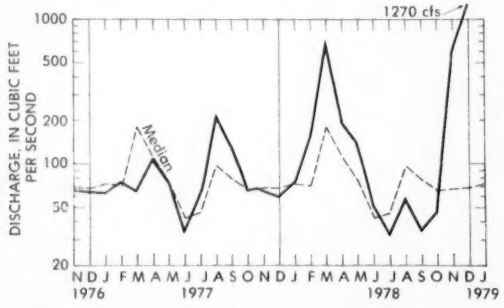
FLOOD DATA FOR SELECTED SITES IN NEW MEXICO AND ARIZONA, DECEMBER 1978

WRD station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known			Maximum during present flood				
				Date	Stage (feet)	Discharge (cfs)	Date	Stage (feet)	Discharge		Recurrence interval (years)
									Cfs	Cfs per square mile	
	NEW MEXICO										
	GILA RIVER BASIN										
09430500	Gila River near Gila	1,864	1914, 1927–	Sept. 29, 1941	17.2	25,400	Dec. 18	12.5	18,000	9.7	100
09431500	Gila River near Redrock.	2,829	1904–55, 1962–	Sept. 29, 1941	31	40,000	19	33–34	45,000	16	>100
09432000	Gila River below Blue Creek, near Virden.	3,203	1914, 1915, 1927–	Sept. 29, 1941	25.78	41,700	19	29.4	60,000	19	>100
09444000	San Francisco River near Glenwood.	1,653	1927–	Oct. 20, 1972	16.61	34,100	18	17.1	19,500	12	>100
	ARIZONA										
	GILA RIVER BASIN										
09442000	Gila River near Clifton ...	4,010	1910–18, 1927–	Oct. 21, 1972	20.0	33,000	Dec. 19	24.8	53,000	13	>100
09444500	San Francisco River at Clifton.	2,766	1910–18, 1927–	Oct. 20, 1972	17.0	64,000	18	16.0	56,000	20	35
09448500	Gila River at head of Safford Valley, near Solomon.	7,896	1914–	Jan. 19, 1916	15.89	100,000	19	14.4	100,000	13	>100
09466500	Gila River at Calva	11,470	1929–	Oct. 20, 1972	15.88	80,000	19	14.2	100,000	9	>100
09468500	San Carlos River near Peridot.	1,027	1929–	Mar. 14, 1941	[1] 11.4	40,600	18	.....	42,000	41	40
09474000	Gila River at Kelvin	18,011	[2] 1929–	Aug. 8, 1930	12.6	42,800	19	25.5	30,000	1.7	15
09484000	Sabino Creek near Tucson.	35.5	1932–	Sept. 6, 1970	10.21	7,730	18	11.76	12,500	352	100
09486500	Santa Cruz River at Cortaro.	3,503	1939–47, 1950–	Oct. 10, 1977	15.4	24,300	18	14.4	19,000	5.4	20
09490500	Black River near Fort Apache.	1,232	1912–15, 1957–	Mar. 2, 1978	22.33	33,200	19	24.2	40,000	32	40
09494000	White River near Fort Apache.	632	1917–18, 1957–	Aug. 12, 1971	13.8	8,670	19	15.7	10,000	16	50
09498500	Salt River near Roosevelt.	4,306	1913–	Mar. 14, 1941	24.4	117,000	19	28.8	90,000	21	35
09499000	Tonto Creek above Gun Creek near Roosevelt.	675	1940–	Sept. 5, 1970	18.2	53,000	18	14.3	44,000	65	20
09502000	Salt River below Stewart Mountain Dam.	6,232	1930–	Jan. 1, 1966	22.4	51,600	20	22.3	53,000	8.5	.....
09505550	Verde River below Camp Verde.	4,670	1924–	Mar. 3, 1938	.....	[3] 97,000	19	26.27	76,000	16	.....
09505800	West Clear Creek near Camp Verde.	241	1964–	Mar. 2, 1978	10.0	13,000	18	11.6	22,000	91	50
09508500	Verde River below Tangle Creek, above Horseshoe Dam.	5,872	1924–	Mar. 3, 1938	19.0	100,000	19	21.44	100,000	17	50
09510000	Verde River below Bartlett Dam.	6,185	[2] 1938–	Mar. 3, 1978	26.38	105,000	18	23.04	75,000	12	.....
09513000	Agua Fria River at Waddell Dam.	1,459	[2] 1929–	March 1978	.....	20,000	18	.....	60,000	41	.....
09513970	Agua Fria River at Avondale.	2,013	1960–	Sept. 6, 1970	11.21	[4] 20,600	19	6.5	[5] 30,000	15	.....

[1] Site and datum then in use.
[2] Period of regulated discharge.
[3] At site 8.5 miles downstream; highest since at least 1924.
[4] Flow partly controlled by Lake Pleasant.
[5] Estimated.

square miles) was highest for any day in period of record that began in August 1945. Monthly and/or daily mean flows of the remaining index stations in the State were highest of record for December and all were above the normal range except for Virgin River at Littlefield in the extreme northwest corner of the State.

In southwestern New Mexico, the monthly mean flow of 1,270 cfs and the daily mean flow of 14,000 cfs on the 19th in Gila River near Gila (drainage area, 1,864 square miles) were highest for any month in 51 years of record. That monthly mean was nearly 19 times median and marked the 2d consecutive month of above-normal flows at that site. (See graph.) In the southeastern part of the State, monthly mean discharge of Delaware River near Red Bluff decreased, but as a result of high carryover flow from November, remained in the above-normal range for the 4th consecutive month. In the northern part of the State, flow of Rio Grande below Taos Junction Bridge, near Taos, decreased in contrast to the normal seasonal trend of increasing flows, and was below the normal range.



Monthly mean discharge of Gila River near Gila, N. Mex. (Drainage area, 1,864 sq mi; 4,828 sq km)

In south-coastal California, where monthly mean flow of Arroyo Seco near Pasadena was above the normal range for the past 12 months, flow increased seasonally to 267 percent of median, but was within the normal range. In the southern Sierra Nevada west slope, monthly mean flow of Kings River above North Fork, near Trimmer, decreased and was below median for the first time since November 1977 but remained in the normal range. In northern California, on the central Sierra Nevada west slope, monthly mean flow of North Fork American River at North Fork Dam increased seasonally but remained in the below-normal range, and was only 22 percent of median. In north-coastal California, monthly mean discharge of Smith River near Crescent City remained in the below-normal range and was only 28 percent of median. Cumulative runoff for the first 3 months of the 1979 water year was only 25 percent of median at Crescent City. Combined contents of 10 major reservoirs in northern California were 110 percent of average and 240 percent of that of a year ago.

In northern Nevada, where monthly mean flows during September, October, and November in Humboldt River at Palisade were above the normal range, flow decreased in December, remained above median but was within the normal range.

In northeastern Utah, streamflow decreased seasonally and remained in the below-normal range in Weber River near Oakley (drainage area, 163 square miles) and Whiterocks River near Whiterocks and decreased into that range in Green River at Green River. The monthly mean discharge of 40 cfs at Oakley was equal to the minimum flow of record for December in period of record that began in 1904. In the southeastern part of the State, monthly mean discharge of San Juan River near Bluff and Colorado River near Cisco increased, contrary to the normal seasonal pattern of decreasing flows, and was above the normal range at both sites. In the western half of the State, flows were generally in the normal range.

In central Colorado, east of the Continental Divide, the monthly mean discharge of 7.0 cfs in Bear Creek at Morrison (drainage area, 164 square miles) was lowest for the month in 63 years of record. Flows have remained in the below-normal range at Morrison for 7 consecutive months and have been lowest of record during the past 5 months. Monthly mean flows of index stations located west of the Divide were near median and within the normal range.

In northern Wyoming, monthly mean flow increased unseasonally and remained in the above-normal range for the 6th time in the past 7 months in Tongue River near Dayton. Elsewhere in the State, mean flows decreased seasonally, were generally above median, but within the normal range.

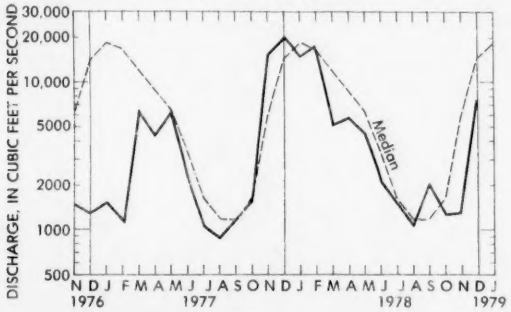
In Montana, streamflow decreased seasonally at all index stations and remained in the below-normal range at Clark Fork at St. Regis and decreased into that range in Middle Fork Flathead River near West Glacier. Both streams are west of the Continental Divide. East of the Divide in south-central Montana, monthly mean discharge of Yellowstone River at Billings was 114 percent of median and remained in the above-normal range for the 6th consecutive month. Upstream at Corwin Springs, streamflow was above the normal range and remained above median for the 7th consecutive month.

In northern Idaho, monthly mean discharge of Clearwater River at Spalding increased seasonally but remained in the below-normal range for the 3d consecutive month. In other parts of the State, mean flows were below the normal range in the Boise and Coeur d'Alene River basins but generally within the normal range in the Snake, Salmon, and Kootenai River basins. Reservoir storage for irrigation in southern Idaho was above average.

In southwestern Alberta, monthly mean flow of Bow River at Banff continued to decrease seasonally but remained above the normal range for the 4th consecutive month as a result of high carryover flow from November. Also in western Alberta, monthly mean flow in Athabasca River at Hinton decreased seasonally, was 125 percent of median, and above the normal range for the 3d time in the past 4 months.

In British Columbia, streamflow decreased seasonally at both index stations, was less than median, but within the normal range.

In Oregon, monthly mean flow increased seasonally at all index stations and was in the normal range except in Wilson River near Tillamook, in the north-coastal area, where mean flow during December was in the below-normal range for the 3d consecutive month. In the southeastern part of the State, where mean flow of Umpqua River near Elkton was below the normal range and only 22 percent of median during November, streamflow increased sharply to 54 percent of median but was within the normal range. (See graph.)



Monthly mean discharge of Umpqua River near Elkton, Oregon
(Drainage area, 3,683 sq mi; 9,539 sq km)

In northwestern Washington, on the western slope of the Cascades, monthly mean flow of Skykomish River near Gold Bar decreased, contrary to the normal seasonal pattern of increasing flows, and was below the normal range at only 61 percent of median. In eastern Washington, streamflow increased seasonally in Spokane River at Spokane, but was only 35 percent of median and remained in the below-normal range for the 3d consecutive month.

Contents of the Colorado River Storage Project decreased 523,600 acre-feet during the month.

Ground-water levels in Washington declined and were below average; a new low for December was reached in the key water-table well at Sumas in the western part of the State. In Idaho, the level in the well penetrating the sand and gravel aquifer in the Boise Valley continued its seasonal decline and was about average. Levels in the key wells in the Snake River Plain aquifer reached new December lows in the eastern, south-central, and southwestern parts and were below average in the western part. The level in the well representative of the alluvial aquifer underlying the Rathdrum Prairie, northern Idaho, declined and was below average. In southern California, ground-water level trends continued to be mixed. In the key well in Los Angeles County, the level declined and continued below average. In Orange County near Los Alamitos in the coastal plain, the level in the key well rose but continued below average. In Santa Barbara County, the level in the well in Santa Ynez Valley rose and continued above average, but the level in the well in Santa Maria Valley declined and continued below average. In Nevada, the level in the Las Vegas well rose but was at a new December low in 32 years of record. Levels declined but were above average in Paradise Valley and Steptoe Valley, and rose and was above average in the well in Truckee Meadows. In Utah, levels rose but were below average in the Holladay and Flowell areas. Levels declined and were below average in the Logan area, and declined but continued above average in the Blanding area. In Arizona, levels declined in two index wells and rose in two others. The level in the well in the Elfrida area, despite a slight rise, was at a new low for December in 27 years of record. The level in the City of Tucson No. 2 well declined slightly and reached a new alltime low in 10 years of record.

ALASKA

Streamflow decreased seasonally at all index stations in the State except in the interior basin of glacier-fed Tanana River basin where mean flow at Nenana increased, contrary to the normal seasonal pattern of decreasing flow and, as a result of snowmelt runoff caused by above-normal temperatures, was in the above-normal range. Also in the interior, where monthly mean flow of Chena River at Fairbanks was below the normal range for 7 consecutive months, May through November, mean discharge continued to decrease seasonally but the rate of recession was less than normal, and mean flow for December was in the normal range but less than median. In the south-central, southeastern, and coastal basins, mean flows decreased but were in the normal range and greater than median.

Ground-water levels in wells tapping confined aquifers in the Anchorage area were generally unchanged from November, except for a decline of over one foot at the North Fork Campbell Creek fan.

HAWAII

Streamflow decreased, contrary to the normal seasonal pattern of increasing flow, except on the island of Hawaii, where monthly mean flow of Waiakea Stream near Mountain View increased seasonally and remained in the normal range for the 5th consecutive month. On the island of Maui, mean flow of Honopou Stream near Huelo decreased but remained in the above-normal range as a result of high carryover flow from November, and was 2 times the December median. On the island of Oahu, where mean flow of Kalihi Stream near Honolulu was above the normal range in November, mean flow decreased into the normal range but remained above median. On the island of Kauai, where mean flow of East Branch of North Fork Wailua River near Lihue also was above the normal range in November, flow decreased sharply and was less than the December median but was within the normal range.

DISSOLVED SOLIDS AND WATER TEMPERATURES FOR DECEMBER AT DOWNSTREAM SITES ON SIX LARGE RIVERS

Station number	Station name	December data of following calendar years	Stream discharge during month	Dissolved-solids concentration during month[a]		Dissolved-solids discharge during month[a]			Water temperature during month[b]		
			Mean (cfs)	Minimum (mg/L)	Maximum (mg/L)	Mean	Minimum	Maximum	Mean, in °C	Minimum, in °C	Maximum, in °C
						(tons per day)					
	NORTHEAST										
01463500	Delaware River at Trenton, N.J. (Morrisville, Pa.)	1978	9,310	89	121	2,580	1,540	5,160	4.5	2.0	9.0
		1944–77 (Extreme yr)	13,550	65 (1949)	130 (1975)	.....	631 (1964)	20,500 (1973)	.....	0	11.0
			[c]10,750								
04264331	St. Lawrence River at Cornwall, Ontario, near Massena, N.Y. median streamflow at Ogdensburg, N.Y.	1978	226,000	163	165	100,000	88,000	105,000	2.5	1.0	4.5
		1975–77 (Extreme yr)	252,500	165 (1976)	170 (1975)	114,000	92,000 (1976)	135,000 (1977)	2.0	0.5	7.0
			[c]229,500								
	SOUTHEAST										
07289000	Mississippi River at Vicksburg, Miss.	1978	866,000	153	281	438,000	308,000	491,000	8.5	6.0	12.5
		1975–77 (Extreme yr)	564,900	171 (1977)	243 (1976)	303,000	131,000 (1976)	486,000 (1977)	6.5	3.5	10.5
			[c]365,200								
	WESTERN GREAT LAKES REGION										
03612500	Ohio River at lock and dam 53, near Grand Chain, Ill. (25 miles west of Paducah, Ky.; streamflow station at Metropolis, Ill.)	1978	609,800	118	272	.....	120,000	457,000	.....	5.0	13.5
		1954–77 (Extreme yr)	299,000	133 (1962)	362 (1969)	.....	26,200 (1955)	469,000 (1977)	.....	0	14.0
			[c]173,000								
	MIDCONTINENT										
06934500	Missouri River at Hermann, Mo. (60 miles west of St. Louis, Mo.)	1978	54,500	362	770	64,700	45,600	110,000	2.5	0	6.5
		1975–77 (Extreme yr)	50,000	304 (1977)	486 (1976)	54,200	35,000 (1976)	133,000 (1975)	3.0	0	7.0
			[c]29,940								
	WEST										
14128910	Columbia River at Warrendale, Oreg. (streamflow station at The Dalles, Oreg.)	1978	139,200	96	119	43,900	22,800	68,300	4.0	0.5	6.0
		1975–77 (Extreme yr)	162,900	82 (1975)	110 (1977)	43,700	23,300 (1976)	66,500 (1975)	8.5	5.5	10.5
			[c]112,800								

[a]Dissolved-solids concentrations when not analyzed directly, are calculated on basis of measurements of specific conductance.
[b]To convert °C to °F: [(1.8 X °C) + 32] = °F.
[c]Median of monthly values for 30-year reference period, water years 1941–70, for comparison with data for current month.

USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF DECEMBER 1978

[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

Reservoir Principal uses: F Flood control I Irrigation M Municipal P Power R Recreation W Industrial	End of Nov. 1978	End of Dec. 1978	End of Dec. 1977	Average for end of Dec.	Normal maximum
	Percent of normal maximum				
NORTHEAST REGION					
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	27	27	80	50	226,300 (a)
QUEBEC					
Allard (P)	87	64	83	55	280,600 ac-ft
Gouin (P)	61	57	74	62	6,954,000 ac-ft
MAINE					
Seven reservoir systems (MP)	41	34	83	57	178,500 mcf
NEW HAMPSHIRE					
First Connecticut Lake (P)	21	21	b2	59	3,330 mcf
Lake Francis (FPR)	83	71	81	69	4,326 mcf
Lake Winnipesaukee (PR)	47	46	82	61	7,220 mcf
VERMONT					
Harriman (P)	36	24	76	59	5,060 mcf
Somerset (P)	76	72	84	66	2,500 mcf
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	64	62	78	72	3,394 mcf
NEW YORK					
Great Sacandaga Lake (FPR)	43	37	69	53	34,270 mcf
Indian Lake (FMP)	75	60	85	61	4,500 mcf
New York City reservoir system (MW)	59	61	100	.....	547,500 mg
NEW JERSEY					
Wanaque (M)	42	41	101	73	27,730 mg
PENNSYLVANIA					
Allegheny (FPR)	32	28	31	30	51,400 mcf
Pymatuning (FMR)	85	87	104	80	8,191 mcf
Raystown Lake (FR)	65	68	62	39	33,190 mcf
Lake Wallenpaupack (PR)	59	58	73	55	6,875 mcf
MARYLAND					
Baltimore municipal system (M)	84	86	81	85	85,340 mg
SOUTHEAST REGION					
NORTH CAROLINA					
Bridgewater (Lake James) (P)	81	75	78	75	12,580 mcf
Narrows (Badin Lake) (P)	92	99	92	94	5,616 mcf
High Rock Lake (P)	30	50	54	63	10,230 mcf
SOUTH CAROLINA					
Lake Murray (P)	82	79	79	58	70,300 mcf
Lakes Marion and Moultrie (P)	71	62	63	59	81,100 mcf
SOUTH CAROLINA--GEORGIA					
Clark Hill (FP)	47	45	62	51	75,360 mcf
GEORGIA					
Burton (PR)	80	69	80	50	104,000 ac-ft
Sinclair (MPR)	76	76	63	71	214,000 ac-ft
Lake Sidney Lanier (FMPR)	37	39	63	51	1,686,000 ac-ft
ALABAMA					
Lake Martin (P)	76	72	73	58	1,373,000 ac-ft
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	26	34	42	31	1,156,000 cfsd
Douglas Lake (FPR)	16	13	14	10	703,100 cfsd
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	39	40	50	37	510,300 cfsd
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	36	39	38	30	1,452,000 cfsd
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	39	43	49	36	745,200 cfsd
WESTERN GREAT LAKES REGION					
WISCONSIN					
Chippewa and Flambeau (PR)	87	72	80	61	15,900 mcf
Wisconsin River (21 reservoirs) (PR)	74	59	68	51	17,400 mcf
MINNESOTA					
Mississippi River headwater system (FMR)	26	25	24	24	1,640,000 ac-ft
MIDCONTINENT REGION					
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	85	84	72	.....	22,700,000 ac-ft
SOUTH DAKOTA					
Angostura (I)	85	93	61	71	127,600 ac-ft
Bell Fourche (I)	55	61	40	43	185,200 ac-ft
Lake Francis Case (FIP)	53	58	63	57	4,834,000 ac-ft
Lake Oahe (FIP)	83	81	69	.....	22,530,000 ac-ft

Reservoir Principal uses: F Flood control I Irrigation M Municipal P Power R Recreation W Industrial	End of Nov. 1978	End of Dec. 1978	End of Dec. 1977	Average for end of Dec.	Normal maximum
	Percent of normal maximum				
MIDCONTINENT REGION Continued					
SOUTH DAKOTA--Continued					
Lake Sharpe (FIP)	103	102	102	93	1,725,000 ac-ft
Lewis and Clarke Lake (FIP)	93	90	95	91	477,000 ac-ft
NEBRASKA					
Lake McConaughy (IP)	61	63	67	70	1,948,000 ac-ft
OKLAHOMA					
Eufaula (FPR)	78	76	85	81	2,378,000 ac-ft
Keystone (FPR)	83	77	91	94	661,000 ac-ft
Tenkiller Ferry (FPR)	88	88	101	90	628,200 ac-ft
Lake Altus (FIMR)	43	44	70	49	134,600 ac-ft
Lake O'The Cherokees (FPR)	71	72	88	79	1,492,000 ac-ft
OKLAHOMA--TEXAS					
Lake Texoma (FMPRW)	84	81	85	90	2,722,000 ac-ft
TEXAS					
Bridgeport (IMW)	36	33	67	44	386,400 ac-ft
Canyon (FMR)	96	99	92	69	385,600 ac-ft
International Amistad (FIMPW)	138	111	95	79	3,497,000 ac-ft
International Falcon (FIMPW)	100	100	89	77	2,668,000 ac-ft
Livingston (IMW)	84	88	100	77	1,788,000 ac-ft
Possum Kingdom (IMPRW)	94	93	82	99	569,400 ac-ft
Red Bluff (PI)	33	33	6	30	307,000 ac-ft
Toledo Bend (P)	88	89	80	78	4,472,000 ac-ft
Twin Buttes (FIM)	62	62	77	27	177,800 ac-ft
Lake Kemp (IMW)	56	57	61	86	268,000 ac-ft
Lake Meredith (FMW)	35	34	37	38	821,300 ac-ft
Lake Travis (FIMPRW)	72	72	75	77	1,144,000 ac-ft
THE WEST					
WASHINGTON					
Ross (PR)	86	67	82	68	1,052,000 ac-ft
Franklin D. Roosevelt Lake (IP)	82	89	89	95	5,022,000 ac-ft
Lake Chelan (PR)	72	58	54	55	676,100 ac-ft
Lake Cushman	75	65	86	85	359,500 ac-ft
Lake Merwin (P)	96	101	101	95	245,600 ac-ft
IDAHO					
Boise River (4 reservoirs) (FIP)	61	64	28	57	1,235,000 ac-ft
Coeur d'Alene Lake (P)	42	31	88	55	238,500 ac-ft
Pend Oreille Lake (FP)	37	35	36	51	1,561,000 ac-ft
IDAHO--WYOMING					
Upper Snake River (8 reservoirs) (MP)	72	76	37	61	4,401,000 ac-ft
WYOMING					
Boysen (FIP)	83	77	67	74	802,000 ac-ft
Buffalo Bill (IP)	71	64	46	68	421,300 ac-ft
Keyhole (F)	78	78	56	41	199,900 ac-ft
Pathfinder, Seminoe, Alcova, Kortes, Glendo, and Guernsey Reservoirs (I)	51	51	40	44	3,056,000 ac-ft
COLORADO					
John Martin (FIR)	0	0	0	14	364,400 ac-ft
Taylor Park (IR)	55	56	36	53	106,200 ac-ft
Colorado-Big Thompson project (I)	42	41	22	55	722,600 ac-ft
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Fontenelle, Navajo, and Blue Mesa Reservoirs (IFPR)	66	65	59	.....	31,620,000 ac-ft
UTAH--IDAHO					
Bear Lake (IPR)	67	69	54	56	1,421,000 ac-ft
CALIFORNIA					
Folsom (FIP)	64	64	21	50	1,000,000 ac-ft
Hetch Hetchy (MP)	66	56	24	35	360,400 ac-ft
Isabella (FIR)	44	43	7	22	570,000 ac-ft
Pine Flat (FI)	64	66	13	43	1,001,000 ac-ft
Clair Engle Lake (Lewiston) (P)	71	64	17	72	2,438,000 ac-ft
Lake Almanor (P)	78	76	52	45	1,036,000 ac-ft
Lake Berryessa (FIMW)	69	68	48	77	1,600,000 ac-ft
Millerton Lake (FI)	50	64	41	53	503,200 ac-ft
Shasta Lake (FIPR)	76	76	24	66	4,377,000 ac-ft
CALIFORNIA--NEVADA					
Lake Tahoe (IPR)	9	8	0	48	744,600 ac-ft
NEVADA					
Rye Patch (I)	22	23	21	55	194,300 ac-ft
ARIZONA--NEVADA					
Lake Mead and Lake Mohave (FIMP)	82	84	78	67	27,970,000 ac-ft
ARIZONA					
San Carlos (IP)	21	45	2	13	1,073,000 ac-ft
Salt and Verde River system (IMPR)	80	89	25	36	2,073,000 ac-ft
NEW MEXICO					
Conchas (FIR)	26	26	31	77	352,600 ac-ft
Elephant Butte and Caballo (FIPR)	5	9	8	27	2,539,000 ac-ft

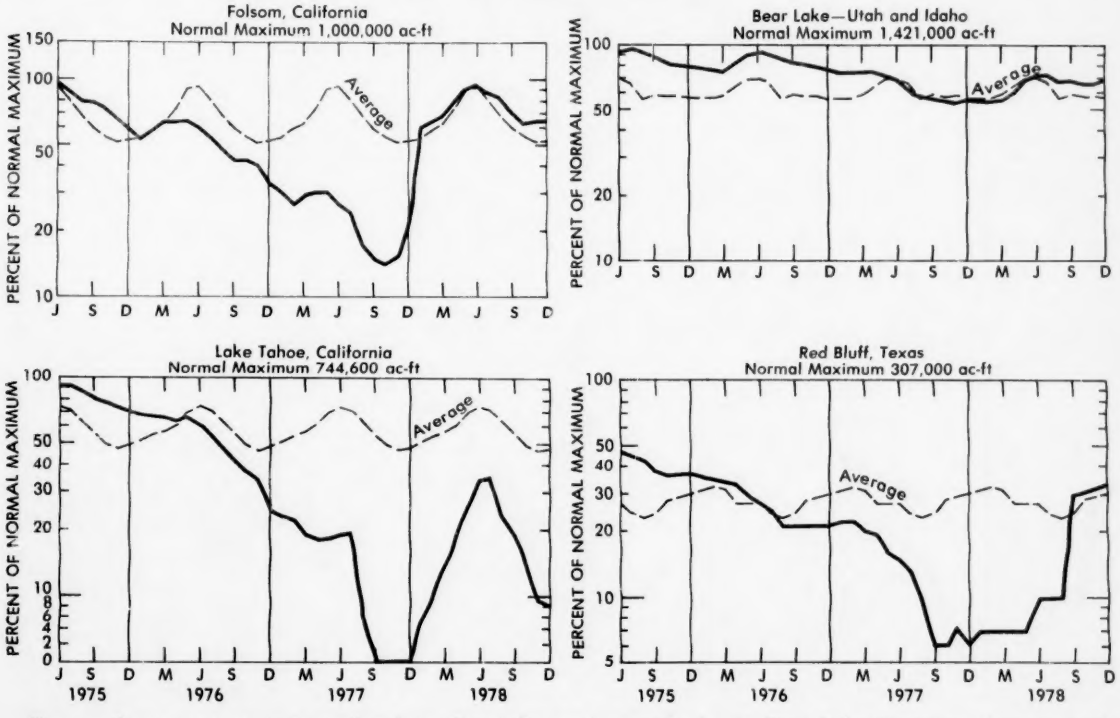
[a] Thousands of kilowatt-hours (the potential electric power that could be generated by the volume of water in storage).
[b] Reservoir drawn down for repairs.

FLOW OF LARGE RIVERS DURING DECEMBER 1978

Station number*	Stream and place of determination	Drainage area (square miles)	Mean annual discharge through September 1975 (cfs)	December 1978					
				Monthly discharge (cfs)	Percent of median monthly discharge, 1941–70	Change in discharge from previous month (percent)	Discharge near end of month		
							(cfs)	(mgd)	Date
1–0140	St. John River below Fish River at Fort Kent, Maine	5,690	9,549	1,863	42	-49	1,060	690	31
1–3185	Hudson River at Hadley, N.Y	1,664	2,853	1,497	66	+7	1,590	1,030	31
1–3575	Mohawk River at Cohoes, N.Y	3,456	5,630	4,120	73	+76	.....	.....	.....
1–4635	Delaware River at Trenton, N.J	6,780	11,630	9,567	89	+132	11,900	7,690	25
1–5705	Susquehanna River at Harrisburg, Pa	24,100	34,200	29,330	101	+126	33,200	21,500	28
1–6465	Potomac River near Washington, D.C	11,560	[1] 11,190	11,400	141	+338	16,000	10,300	31
2–1055	Cape Fear River at William O. Huske Lock near Tarheel, N.C	4,810	5,007	3,970	108	+196	2,920	1,890	31
2–1310	Pee Dee River at Peedee, S.C	8,830	9,657	6,160	89	+80	4,780	3,090	28
2–2260	Altamaha River at Doctortown, Ga	13,600	13,780	4,706	65	+102	5,340	3,450	31
2–3205	Suwannee River at Branford, Fla	7,880	6,970	2,320	68	-4	2,180	1,410	28
2–3580	Apalachicola River at Chattahoochee, Fla	17,200	22,330	9,220	57	+9	11,900	7,690	29
2–4670	Tombigbee River at Demopolis lock and dam near Coatopa, Ala	15,400	22,570	8,037	44	+328	7,550	4,880	29
2–4895	Pearl River near Bogalusa, La	6,630	9,263	4,468	93	+159	3,150	2,040	31
3–0495	Allegheny River at Natrona, Pa	11,410	[1] 19,210	27,084	140	+167	29,100	18,800	27
3–0850	Monongahela River at Braddock, Pa	7,337	[1] 12,360	36,671	265	+449	31,300	20,200	27
3–1930	Kanawha River at Kanawha Falls, W.Va	8,367	12,530	16,480	126	+610	14,100	9,100	25
3–2345	Scioto River at Higby, Ohio	5,131	4,513	7,779	478	+287	3,420	2,210	27
3–2945	Ohio River at Louisville, Ky[2]	91,170	114,100	299,800	338	+422	209,200	135,200	26
3–3775	Wabash River at Mount Carmel, Ill	28,635	27,030	31,850	212	+132	20,000	13,000	31
3–4690	French Broad River below Douglas Dam, Tenn	4,543	[1] 6,794	5,008	99	+188	.....	.....	.....
4–0845	Fox River at Rapide Croche Dam, near Wrightstown, Wis[2]	6,150	4,185	4,625	140	-39	.....	.....	.....
02MC002 (4–2643.31)	St. Lawrence River at Cornwall, Ontario–near Massena, N.Y[3]	299,000	241,100	224,900	98	-10	200,000	129,000	31
050115	St. Maurice River at Grand Mere, Quebec	16,300	25,300	9,800	77	-11	22,000	14,200	28
5–0825	Red River of the North at Grand Forks, N. Dak	30,100	2,524	740	84	-7	740	480	31
5–1335	Rainy River at Manitou Rapids, Minn	19,400	12,950	10,650	113	+25	10,500	6,790	27
5–3300	Minnesota River near Jordan, Minn	16,200	3,412	387	59	-14	445	288	22
5–3310	Mississippi River at St. Paul, Minn	36,800	[1] 10,580	5,200	111	-15	5,600	3,600	22
5–3655	Chippewa River at Chippewa Falls, Wis	5,600	5,110	3,188	112	+9	.....	.....	.....
5–4070	Wisconsin River at Muscoda, Wis	10,300	8,613	6,739	118	-9	.....	.....	.....
5–4465	Rock River near Joslin, Ill	9,551	5,852	4,970	163	+7	4,400	2,800	31
5–4745	Mississippi River at Keokuk, Iowa	119,000	62,570	38,725	113	-15	36,600	23,600	31
6–2145	Yellowstone River at Billings, Mont	11,796	6,986	3,401	114	-17	3,000	1,900	31
6–9345	Missouri River at Hermann, Mo	524,200	79,750	54,170	181	-28	40,800	26,400	26
7–2890	Mississippi River at Vicksburg, Miss[4]	1,140,500	573,600	866,000	237	+209	1,040,000	672,000	31
7–3310	Washita River near Durwood, Okla	7,202	1,414	162	38	-6	145	94	31
8–2765	Rio Grande below Taos Junction Bridge, near Taos, N. Mex	9,730	724	349	75	-19	360	230	31
9–3150	Green River at Green River, Utah	40,600	6,366	1,495	73	-32	3,000	1,900	31
11–4255	Sacramento River at Verona, Calif	21,257	19,150	11,550	57	+8	11,700	7,560	22
13–2690	Snake River at Weiser, Idaho	69,200	18,170	15,680	105	+5	16,400	10,600	27
13–3170	Salmon River at White Bird, Idaho	13,550	11,290	4,141	95	-12	4,290	2,770	26
13–3425	Clearwater River at Spalding, Idaho	9,570	15,570	12,130	183	+82	11,600	7,500	27
14–1057	Columbia River at The Dalles, Oreg[5]	237,000	194,600	64,600	72	-20	.....	.....	.....
14–1910	Willamette River at Salem, Oreg	7,280	23,810	35,300	82	+429	23,300	15,100	27–31
15–5155	Tanana River at Nenana, Alaska	25,600	23,850	7,884	118	+1	7,400	4,800	31
8MF005	Fraser River at Hope, British Columbia	83,800	96,400	34,100	81	-35	29,400	19,000	27

[1] Adjusted.
[2] Records furnished by Corps of Engineers.
[3] Records furnished by Buffalo District, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.
[4] Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.
[5] Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.
*The U.S. station numbers as listed in this table are in a shortened form previously in use, and used here for simplicity of tabular and map presentation. The full, correct number contains 8 digits and no punctuation marks. For example, the correct form for station number 1–3185 is 01318500.

USABLE CONTENTS OF SELECTED RESERVOIRS AND RESERVOIR SYSTEMS, JUNE 1975 TO DECEMBER 1978



Near or above-average contents continued to characterize most reservoirs in the West during December. However, much below-average contents characterized reservoirs in New Mexico and Nevada, including Lake Tahoe on the Nevada–California border. (See graph above.)

WATER RESOURCES REVIEW

December 1978

Based on reports from the Canadian and U.S. field offices; completed January 16, 1979

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EXPLANATION OF DATA

Cover map shows generalized pattern of streamflow for December based on 20 index stream-gaging stations in Canada and 130 index stations in the United States. Alaska and Hawaii inset maps show streamflow only at the index gaging stations which are located near the points shown by the arrows.

Streamflow for December 1978 is compared with flow for December in the 30-year reference period 1941–70. Streamflow is considered to be *below the normal range* if it is within the range of the low flows that have occurred 25 percent of the time (below the lower quartile) during the reference period. Flow for December is considered to be *above the normal range* if it is within the range of the high flows that have occurred 25 percent of the time (above the upper quartile).

Flow higher than the lower quartile but lower than the upper quartile is described as being *within the normal range*. In the Water Resources Review the median is obtained by ranking the 30 flows of the reference period in their order of magnitude; the highest flow is number 1, the lowest flow is number 30, and the average of the 15th and 16th highest flows is the median.

The normal is an average (but not an arithmetic average) or middle value; half of the time you would expect the December flows to be below the median and half of the time to be above the median. Shorter reference periods are used for the Alaska index stations because of the limited records available.

Statements about *ground-water levels* refer to conditions near the end of December. Water level in each key observation well is compared with average level for the end of December determined from the entire past record for that well or from a 20-year reference period, 1951–70. *Changes in ground-water levels*, unless described otherwise, are from the end of November to the end of December.

The Water Resources Review is published monthly. Special-purpose and summary issues are also published. Issues of the Review are free on application to the Water Resources Review, U.S. Geological Survey, Reston, Virginia 22092.

SUMMARY APPRAISALS OF THE NATION'S GROUND-WATER RESOURCES—ALASKA

The abstract and illustrations below are from the report, *Summary appraisals of the Nation's ground-water resources—Alaska*, by Chester Zenone and Gary S. Anderson: U.S. Geological Survey Professional Paper 813-P, 28 pages, 1978. This report may be purchased for $1.60 from the Branch of Distribution, U.S. Geological Survey, 1200 S. Eads St., Arlington, VA 22202 (check or money order payable to U.S. Geological Survey); or from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (payable to Superintendent of Documents).

ABSTRACT

Alaska has enormous surface-water resources, but many of the streams are frozen for most of the year and most contain glacial silt that makes them unacceptable for human use. These factors lend special significance to ground water as a water-supply source, even though perennially frozen ground (permafrost) profoundly modifies ground-water flow systems in much of Alaska north of the maritime southern coast and southeastern panhandle areas. (See figures 1 and 2.) Frozen ground is a virtually impermeable layer that restricts recharge, discharge, and movement of ground water, acts as a confining layer and limits the volume of unconsolidated deposits and bedrock in which water may be stored.

Ground water is an untested resource in most of Alaska, but in many areas potential development of ground water far exceeds current use. Alluvium of major river valleys, such as the Yukon, Tanana, Kuskokwim and Susitna Rivers, probably contains the most extensive aquifers in the State. Large amounts of ground water are also stored in glacial outwash aquifers that underlie coastal basins and valleys, such as those at Kenai and Anchorage in the Cook Inlet lowland. Individual wells yielding more than 1,000 gallons per minute have been developed in the Tanana River valley, Cook Inlet lowland, and the coastal valleys at Seward and Juneau. Comparable yields should be possible in other areas that have similar geohydrologic environments. No major aquifers have been identified in glacial and glaciolacustrine deposits of interior valleys or in deltaic deposits. Major bedrock aquifers have been identified only in carbonate rocks of the Brooks Range and on the north side of the Alaska Range. Springs issuing from the carbonate rocks of the Brooks Range have discharges as great as 16,000 gallons per minute.

Most ground-water recharge occurs beneath reaches of stream channels that are losing flow to the ground-water system. Most ground-water discharge also takes place along reaches of stream channels. This discharge augments streamflows during summer and maintains low flows during winter when there is no surface-water runoff. On the basis of a streamflow hydrograph separation technique and using the 60 percent flow-duration value as an indicator of ground-water discharge, it is estimated that 25 percent of the total volume of streamflow in Alaska (exclusive of coastal, maritime environments) is contributed by ground-water discharge.

The thawing of frozen ground in the permafrost regions of Alaska causes construction and engineering problems. Disturbance of the ground surface disrupts the natural thermal equilibrium and tends to thaw part of the permafrost. Thawing can cause loss of strength, a decrease in volume, and an increase in erosion potential, particularly if the frozen ground is fine grained and poorly drained.

Present deficiencies in the ground-water information base are obvious limiting factors to ground-water development in Alaska. There is a need to extend the ground-water data-collection network and to pursue special research into the quantitative aspects of ground-water hydrology in cold regions, particularly the continuous permafrost zone.

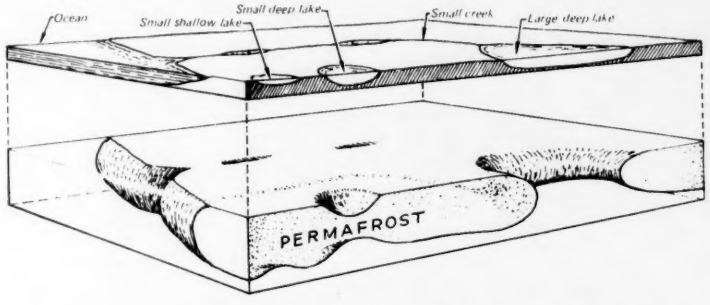

Figure 1.—Schematic representation of the effect of bodies of water on the configuration of permafrost in the continuous permafrost zone.

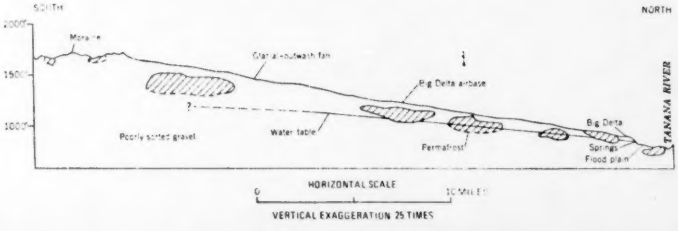

Figure 2.—Diagrammatic sketch showing cross section of permafrost and ground water in the Big Delta area.

INT 1735-79